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INDUCTIVE RADIO COMMUNICATION IN RAIL TRANSPORTATION

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The first experiments with train communication were conducted in 1926 by the State Experimental Electrical Engineering Institute. These experiments are evidence of the priority of Soviet engineering in bringing about radio communication in railroad transportation.

During the postwar Five-Year Plan, our radio engineering made great strides; this progress was reflected in the extent of its use in the field of transportation. Our railroad transportation system received the specially designed radio station ZhR-1, with which locomotives on a number of railroad lines have already been equipped. In 1949, engineers N. M. Mikhalenko, B. F. Karro-Est, G. P. Sitnikov, G. V. Khubayev, and N. A. Metass were awarded the Stalin Prize for developing this station.

The radio station ZhR-1 operates on the 100-m band. The master oscillator of the transmitter and the heterodyne oscillator of the receiver use crystal control. Fixed, stabilized frequencies permit rapid calling of the other party and make it unnecessary to tune the equipment during communication. With an antenna power of only a few watts, ZhR-1 provides positive communication within a radius of approximately 6 km. The station on the locomotive obtains its power from the same turbogenerator which supplies the lighting system. The stationary radio installation is supplied from the ac line through a voltage regulator.

Following the introduction of ZhR-1, the number of problems pertaining to scientific research on the use of radio communication in transportation was increased. In particular, the rules governing the propagation of electromagnetic energy under the specific conditions existing on railroad lines were subjected to study.

It had long been observed that radio waves are propagated especially well along rivers, power lines, communication lines, etc. This phenomenon plays an extremely important part in train communications since, as a rule,

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there are wire lines along the railroad line. Tests conducted along a section of the Moscow-Ryazan' Railroad System confirmed this effect and showed that the range of transmission should be greater along railroad lines than under usual conditions.

Thus, there are different methods of solving the technical problems involved in radio communication with moving trains:

1. Pure radio communication, in which the energy of the radio waves is propagated from the transmitting to the receiving antenna through free space without any auxiliary links.

2. Inductive radio communication, in which the electromagnetic energy is propagated from the transmitting to the receiving antenna through unique ducts consisting of the wires of overhead lines; through electromagnetic induction, part of the energy is transmitted from the bundle of wires to the antenna of the moving station, and likewise in the reverse direction.

The second method gives greater range than the first. Over short distances, e.g., within a railroad switching yard, it is efficient to use pure radio communication; over greater distances, however, for example, in establishing communication with train engineers on a run, inductive radio communication is preferable.

In 1947-1948, a section of the Yaroslavl' Railroad System was equipped for radio communication between locomotive engineers, dispatchers, and station attendants. Signal engineers of the Omsk Railroad System, where train radio communication had already been used extensively, took the initiative.

In the railroad stations of the section, there are control panels and radio transmitters which are linked with the control board of the dispatcher. Through a selector unit, and using his regular dispatching lines, the dispatcher can connect himself to any of the radio stations along the railroad line to which the desired train may be nearest at a given moment. In the reverse direction, i.e., from the locomotive to the stationary terminal, communication is established between the engineer and the station attendant. The tests showed that this type of communication is the most desirable from the standpoint of railroad operations.

The use of radio communication in railroad transportation in recent years gives evidence of the great efficiency of this new field of engineering.

Among the advantages gained by the use of radio communication is the great help it affords in securing movement on schedule, making fuller use of locomotives, improvement of their operation, and increase in traffic safety. Furthermore, by improving operational control of train movements, radio communication brings considerable savings.

In the use of radio communication for transportation, the need arose for generalization of experience and development of theoretical principles. Recently, a group of workers of the Radio Engineering Chair, Leningrad Electrical Engineering Institute for Signal and Communications Engineers of the Ministry of Transportation, has studied inductive radio communication, its characteristics, and its practical problems. The peculiarities of propagation of electromagnetic energy along a cluster of wires was examined for different frequencies, and practical radio communication at different wave lengths and distances between locomotive and railroad station transmitters was investigated. These studies reveal the mechanism of inductive radio communication in broad outline as follows:

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The antenna of the stationary transmitter is coupled inductively or capacitively to the wires of the communication line following the railroad. The electromagnetic energy propagated along this bundle of wires induces an emf in the adjacent wires and in the rails. The antenna of the locomotive radio station is exposed to these induced fields. The emf induced in the antenna is fed to the receiver of the locomotive radio station.

In the reverse direction, communication is accomplished in the following manner: From the transmitter of the locomotive station the energy travels to the antenna and induces an emf in the bundle of wires and in the rails. The electromagnetic energy propagated along the wire transmission lines reaches the receiving antenna of the stationary radio installation and through induction produces an emf in the input section of the receiver.

Research disclosed that not every type of wire bundles makes a good duct for channeling high frequency energy. Most suitable are lines which contain wires made of nonferrous metals (bronze, bimetal). The effective range of inductive communication along steel wires is considerably shorter since such lines have greater attenuation. The range of inductive communication also depends on the frequency used. Thus, for example, the attenuation is approximately half as great for a wave length of approximately 2,000 m than for a wave length of about 100 m. The decisive factor seems to be the conditions governing the transfer of energy from the wires to the locomotive antenna, and conversely. This condition determines the maximum permissible distance between antenna and line. The higher the frequency, the greater this distance can be.

In the future, a quantitative increase in radio facilities in transportation can be expected, along with further uses of radio communication. In the near future, it may be possible to use inductive radio communication in establishing connection between trains and the city telephone networks. This would make it possible for a passenger on a moving train to carry on a telephone conversation with subscribers of localities having telephone facilities.

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